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Mechanical Lubrication

by

Fred Viall Larkin

A Thesis Submitted for the Degree of
Bachelor of Science
General Engineering Course

University of Wisconsin

1906

Table of Contents.

Part I. General Discussion.

1. Introduction:
    - (a) Definition of Mechanical Lubrication.
    - (b) Requirements of a good Lubricator.
2. Chronological Summary:
    - (a) Oil can type.
    - (b) Gravity type.
    - (c) Grease cup type.
    - (d) Condensation type.
    - (e) Differential piston type.
    - (f) Plunger displacement type.
    - (g) Automatic pressure pump type.

Part 2. Design of a Mechanical Lubricator.

1. Object of Design.
2. Specifications.
3. Claims.
4. Estimate of cost of Manufacture.
5. Results of tests.
6. General Conclusions.
7. List of patents examined.

Part I.

Introduction.

Definition of Mechanical Lubrication: Mechanical Lubrication is the process of automatically interposing lubricating fluids between solid machine surfaces that are required to slide over each other. The object of lubrication of any kind, whether it be done automatically or by hand, is to lessen friction

Friction is injurious in that it wears away the surfaces in contact and thus destroy the fit between them, and, in that it dissipates and renders useless part of the energy transmitted through the machine.

The essential functions of a lubricant is the mechanicalseparation of the lubricated surfaces by a layer of fluid of finite thickness. Experiments and experience have both shown that continual rubbing, with the consequent heating effects, tend to cause a lubricant to deteriorate and disappear. Lubricants, then, to give a maximum efficency must be renewed at intervals as they are worn away.

The difference between the weat on improperly lubricated surfaces and that on properly lubricated surfaces is so serious that a comparison between the cost of lubrication and the money saved in the avoidance of repairs is superfluous. Experience is doubtless the most convincing argument that can be brought forward in favor of proper lubrication. A line

shaft, carefully put in place and kept in alignment, may, with proper lubrication, run at the rate of from 200 to 300 revolutions per minute, for ten hours a day, year in and year out, without any noticable wear. The reason is, that a film of oil holds the surfaces apart and never permits metallic contact. Metallic surfaces, which, rubbing together become dry, will cut each other and cause an abrasion to take place. The bearing will then require more lubricant, and give a lower efficency. Quite a striking and perhaps the most common example of inefficent lubrication, with the consequent abrasion and excessive friction, is the setting of a vehicle wheel, in which case the friction at the axle is greater than the friction along the ground.

It has been stated that most worn out machines have been discarded for defects which are directly tracable to inefficent lubrication, and an inspection of a junk pile will substantiate such a statement to a surprising degree. The life of a machine, run under proper conditions, with moisture and dirt kept away, is indefinite, as, when properly lubricated, an oil film holds the surfaces apart and prevents metallic contact. Abrasion of the metal will then only occur when dirt and gritty substances find their way into the bearing, via the oil, or through the oil holes.

Engineers have always recognized the need of lubrication. Most machines have been so designed as to permit of the lubrication of rubbing parts. Simple machines require

simple methods of lubrication. It is only with the introduction of steam, gas, and compressed air, that complicated systems of lubrication have been demanded. It may be accepted as a general rule, that the higher the grade and the greater the cost of a machine, the more attention is paid to its proper lubrication. Thus it is in power plants and on other high classes of machinery that there is found, today, the most efficent systems of lubrication. Many of these systems are elaborate and satisfactory in their results as far as they go. They depend upon gravity for their action, and require the attention of the engineer on starting and stopping. When an engineer's only duty is to look after the proper running of his engine, such a lubricating system is little extra care. When, however, an engineer has many other things to look after, as is the case with the automobile chauffeur, the lubricating system should be entirely automatic. It is perfectly evident, too, that a gravity system cannot be satisfactorily and economically arranged to lubricate valves and piston against a pressure of from forty to two hundred pounds per square inch. It is the demand for a pressure lubricating system that has called into existence the various types of force feed lubricators.

Automobiles have doubtless done more than any other one class of machines to bring about perfection in mechanical lubrication. On the early automobiles an oil cup was the only means of lubricating, and it was considered good enough; but

when more powerful and elaborate cars came to be built, designers realized the total inadequacy of such a system and demanded something better. Busy with their own experementing, and constructing, they naturally turned to the manufacturers of automobile accessories for a more perfect lubricating system. The response of the manufacturers is most forcibly shown by the list of patents granted on oiling devices during the last five years.

Requirements of a good Lubricator: The users of high grade machinery have come to demand that a lubricating system possess the following essentials, namely: (1) automatic action, that is, that it start and stop with the engine, independent of the operator, (2) positive and regular delivery of oil to parts to be lubricated. (3) individual regulation of the amount of oil delivered from each feed pipe without opening or stopping the lubricator. (4) sight feed or equivalent to enable operator to determine whether or not oil is flowing.

Chronological Summary: The present high grade, automatic, force feed, pump which has made possible such exacting demands, is the product of a series of experiments which started with the ordinary oil can with which lard or tallow, when warmed, were administered to the rubbing surfaces. Even though the oil can is an extremely simple device, considerable pains has been taken to bring its design through the successive stages shown in the cuts on the following page.

Bronzed
Steel
Engineers'
Fillers.

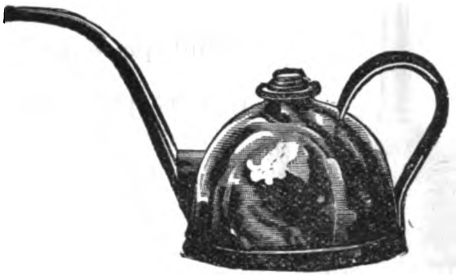
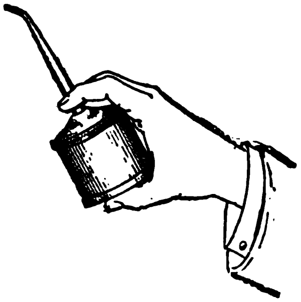
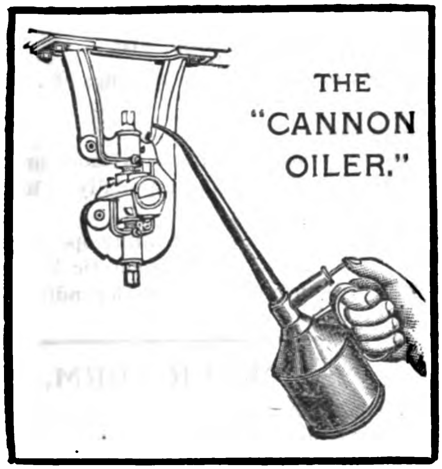


Fig. 1.



THE MILLER AUTOMATIC AUTO OILER.

Fig. 2.

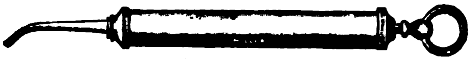


YOU DO NOT TILT THE CAN

YOU PUSH THE PLUNGER

Fig. 3.

Miller Oil Gun.



Furnished in polished brass.

Fig. 4.

Following the oil can, came the elevated tank, or gravity system, of lubrication. In this system an elevated tank furnished the pressure, the oil being transmitted through pipes to the points of lubrication where its outflow is regulated by means of needle valves. Such a system is shown in Fig. 5.

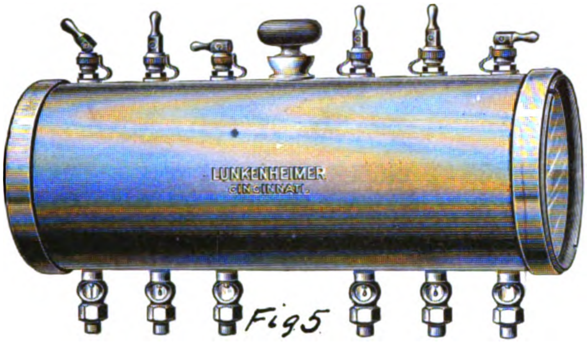
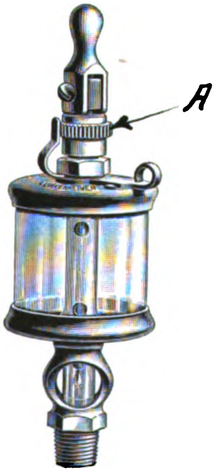


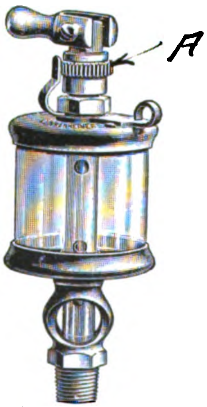
Fig 5

A great number of sight feed, gravity, oil cups have been manufactured and put upon the market. While their principle is a common one, they differ somewhat in detail. One of the most satisfactory oil cups is that shown in Figs. 6 & 7. Adjustment of amount of oil fed is made by means of the milled screw shown at A.



Lever up, cup feeding.

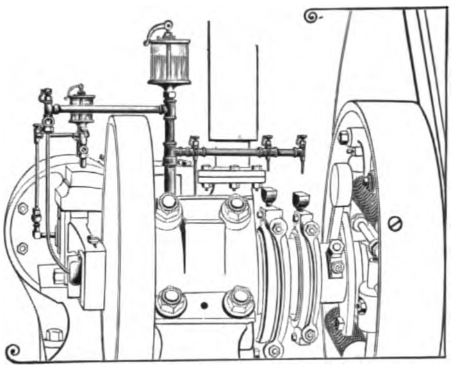
Fig. 6.



Lever down, feed stopped.

Fig. 7

A very satisfactory arrangement for oiling the bearings on a stationary or on a marine engine is shown in Fig. 8.



DEVICE FOR OILING CRANK PIN, PILLOW BLOCK AND ECCENTRICS FROM ONE OIL CUP

Fig. 8.

A modification of the gravity type of oiler is the pressure feed type, which includes the pressure tank and the ordinary grease cup. Fig. 9 represents a pressure lubricating system, in which the pressure in the tank is created by exhaust from the engine, by an air pump, or by water pressure. The sight feeds are shown at A, and the adjusting screws at B. The

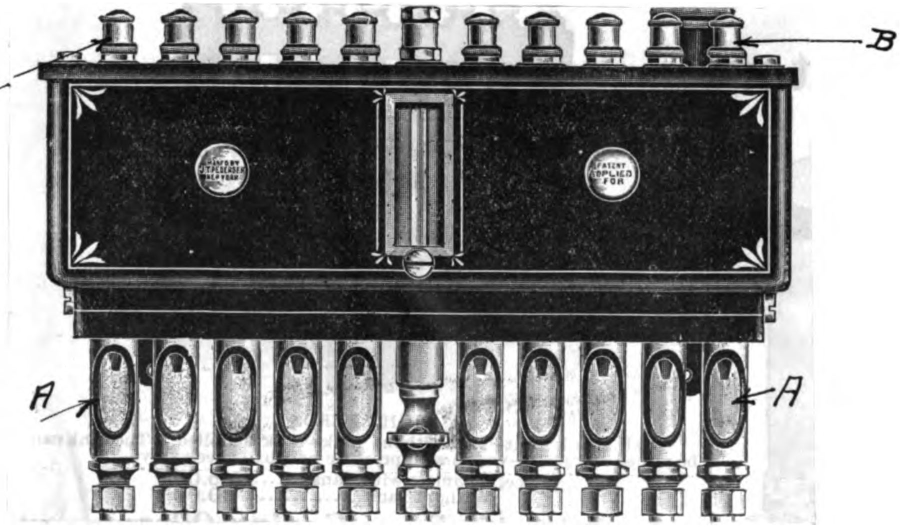
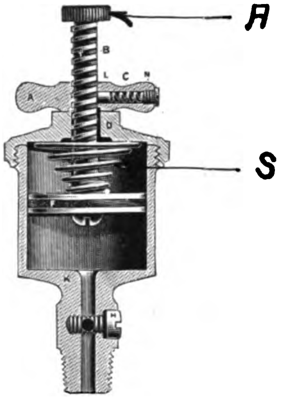


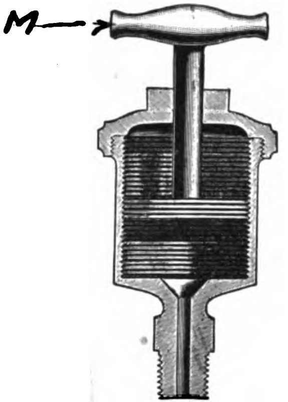
Fig. 9.

ordinary pressure grease cup is shown in Figs. 10 & 11.



Sectional.

Fig. 10.



Sectional.

Fig. 11.

The cup shown in Fig. 10 is automatic, in that the tension in the spring, S, can be adjusted by means of the thumb nut, A, and the amount of grease discharged is regulated by means of the screw, H, which controls the size of the discharge port. The cup shown in Fig. 11 is one designed to force grease at some distance. It is operated by turning the thumb nut, M, at intervals.

While it is only a step from these semi- automatic grease cups to a more recent automatic plunger displacement pump, the condensation type of lubricator is the next in chronological order. Such a lubricator is shown in Figs. 12 & 13.

Fig. 12.

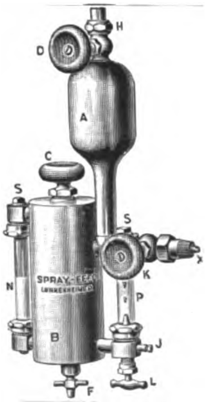
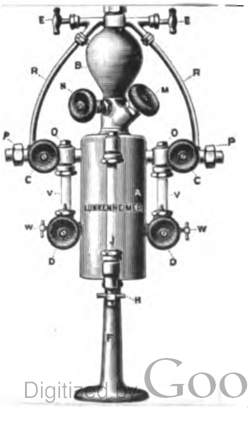


Fig. 13



This lubricator was practically the first called into existance for the purpose of forcing oil into a cylinder or steam pipe against pressure. Referring to Fig. 12, connection is made to the steam pipe at, X, and, H, and the pressure on both sides of the oil is practically boiler pressure. By means of the chamber, A, steam is condensed and the chamber, A, as well as the pipe leading down to the oil are filled with water, which makes the pressure on the top of the oil, greater than that on the bottom, by an amount per square inch, equal to the pressure per square inch due to the column of water from the oil up to A. The oil is forced out at, B, and being lighter than water rises through the water column, P, and passes to the engine through the connection, X, The amount of flow is regulated by the needle valve, L. While various types of condensation lubricators have been placed upon the market, each an improvement on its predecessor, they all work on the same principle and accomplish the same results.

Next came the differential piston type of lubricator, see Fig. 14. Connection was made to the engine at A. The back pressure on the oil when the feed is open would be the same as that at, A, were it not for the differential piston, D. The stem of the piston is guided through a packing gland at D', against atmospheric pressure, leaving a pressure on the oil equal to boiler pressure times the area of cross section of the stem. This pressure is sufficent to force the oil out at C, where it rises through the water column, E, and passes

to the engine. This style of lubricator has been made with a diaphragm in place of the larger piston so as to avoid packing the piston and prevent friction and leakage.

Both the condensation and the differential piston types of lubricator were, however, unsatisfactory in that they operated entirely independent of the speed of the engine. The first lubricator designed to take into consideration the speed of the engine was of the plunger displacement type shown in Figs. 15 & 16.

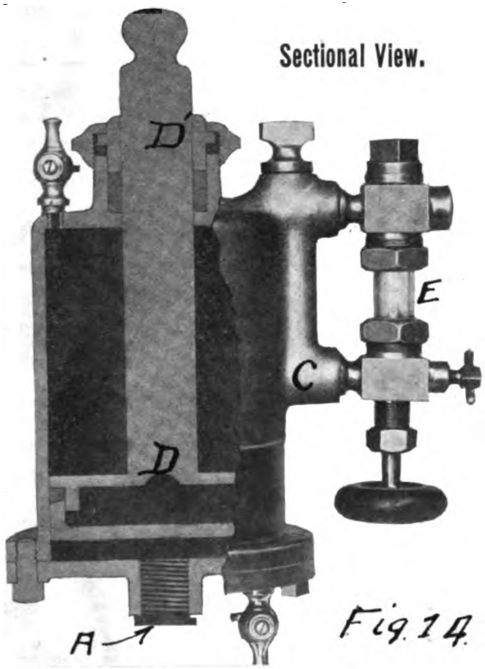


Fig 14

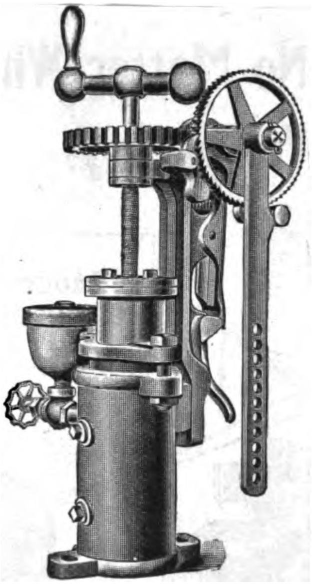


Fig. 16.

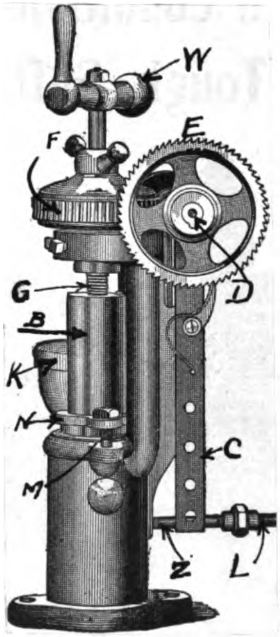


Fig. 15.

Referring to Fig. 15, connection was made to the valve rod of the engine by means of the arm, C. The arm, C, in oscillating back and forth, turned the ratchet wheel, E, the worm shaft, D, and consequently the worm, F, and the screw, G, thus forcing the plunger, B, gradually into the chamber packed at M, N, causing the oil to pass to the engine through the pipe

L. As soon as the plunger, B, reached the end of its downward stroke the worm was automatically thrown out. The plunger had then to be raised by means of the hand wheel, W, connection to the engine shut off at, Z, and the lubricator refilled at K. This pump was far too crude to find very wide application. It served merely as a stepping stone to the later high grade, automatic, pressure pump.

As stated before, the automatic, pressure, pump was created to meet the demands of the automobile trade, and, as a consequence, we find them used almost exclusively on automobiles. Of this class of pumps there are two distinct types, those using ball valves, and the so called valveless. Fig. 17 shows a sectional view of one of the ball valve pumps.

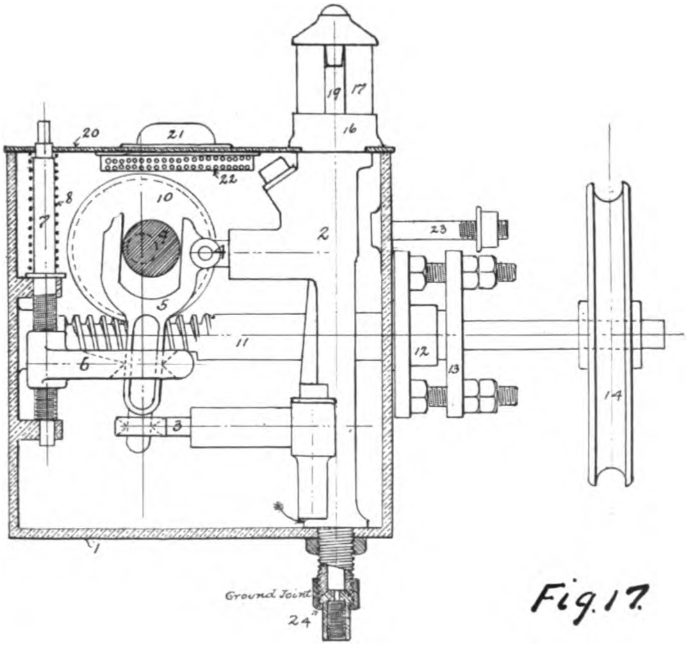


Fig. 17

Quoting directly from the makers catalogue, "the lubricator consists of a rectangular resevoir, and cover, provided with a filling opening closed by a plug, 21, the oil when poured into the resevoir passing through a perforated sheet metal strainer, 22, which prevents any solid particles getting into the tank. The force feed mechanisn consists really of two pumps, (3 & 4). The stroke of the pump, 3, can be adjusted from the top of the lubricator without removing the cover. The second pump, 4, has a constant stroke, and forces the oil after it has dropped through the sight feed glasses, 17, on to the point of lubrication. At the bottom of the sight feed glasses a gauze screen is placed as an additional protection to prevent even the smallest particle of foreign matter being forced to the bearings. This is in full view of the operator and can be removed by taking off the brass cup. These sight feed glasses are simply a protecting case for the oil drops, and contain no liquid, which has proved a great disadvantage in the liquid sight feed glasses. The amount of oil being pumped is at all times visible to the operator."

The operation is as follows:

The pumps are driven by an eccentric, 9, and an adjustable lever, 5, by means of a worm gear, 11, connected to the cam shaft or other rotating part of the engine by the pulley or sprocket, 14. The stroke of the supply pump, 3, is increased or diminished (thus increasing or diminishing the amount of oil pumped) by means of the sliding arm, 6,

which forms a movable fulcrum for the pump lever, 5. When the regulating stem, 7, is screwed down the fulcrum is raised and the stroke of the pump piston is lengthened. Lowering the fulcrum decreases the stroke of the pump piston and diminishes the amount of the oil pumped. This pump delivers the oil through the oil stand pipe, 19, from which it drops to the delivery pump, 4, attached to the jaws of the operating lever. The stroke of the pump is constant, and every drop of oil which falls into the pump chamber must be forced out through the delivery pipe, 24, and on to the point of lubrication."

The advantages claimed for this pump by the manufacturers are the following: "First, it insures lubrication in proportion to the speed; second, it gives absolute and unfailing delivery of the amount of oil pumped to the bearings; third, the amount of oil pumped is always in sight of the operator; fourth, there are no liquid sight feeds to become cloudy or freeze; fifth, the amount of oil to each bearing is regulated from outside the lubricator without removing the covers; sixth, the height of the lubricator being so small, it can be placed well upon the dash in full view of the operator."

In Figs. 18, 19, 20, 21, are shown sectional views of a so-called valveless pump. Referring to Fig. 18, and quoting directly from the manufacturers catalogue, this oiler "consists of a cast iron base, A, with segmental seat for a series of

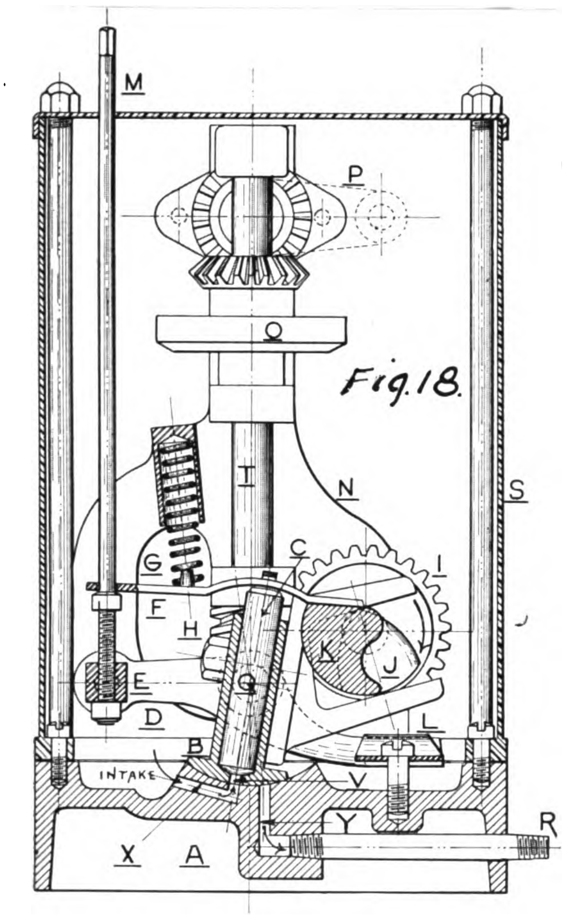


Fig. 18.

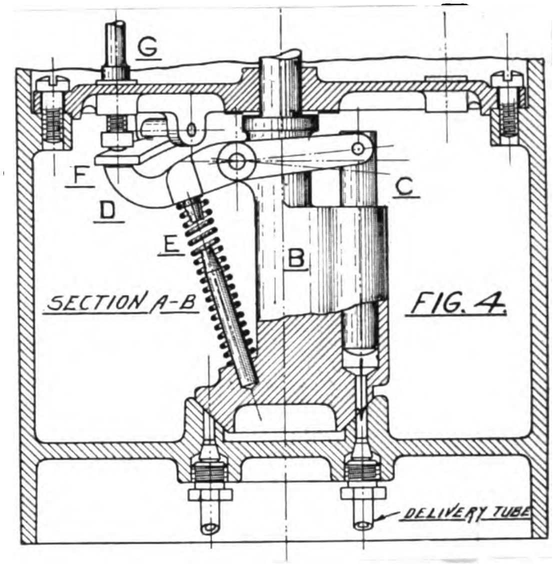
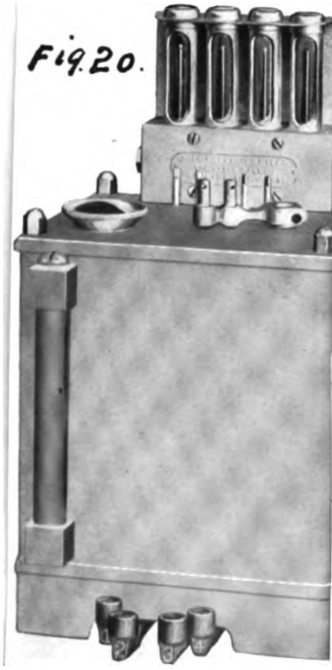


Fig. 19.

Fig. 20.



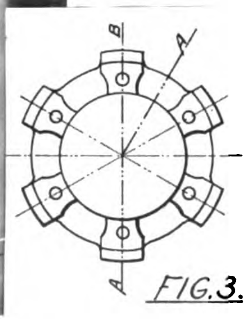


FIG. 3.

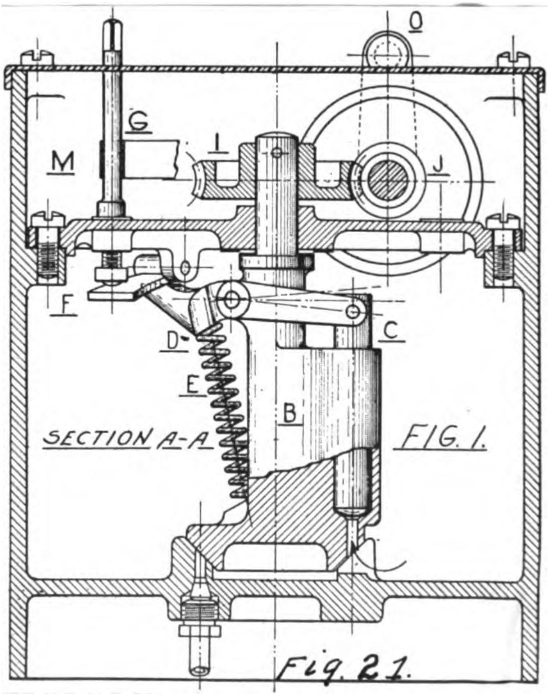


Fig. 21.

cylinders, B, fitted with plungers, C, and oscillating on trunions, Q, with other necessary actuating devices contained in oil tank, S, the working parts being immersed in oil, and consequently self lubricating. P, is the operating ratchet lever, driven by a suitable connecting rod, receiving a reciprocating motion from some moving part of the engine. Motion is communicated to the main shaft, I, by a pair of bevel gears and operating cams, J, and K, through the worm, H, and the gear j. O, is a ratchet clutch on the main shaft, I, to release the shaft when the connecting rod is on its back stroke, and is not a part of the equipment when a pulley or a sprocket drive is used. The oil tank, S, is provided with a protected glass gauge, to show the height of the oil in the tank, and a drain plug, for emptying the tank when desired. The tank is filled through a strainer cap in its top." The gauge, drain plug, and filler cap, show in Fig. 20.

"The essential features of operating this oiler are as follows: In the position shown in the figure, the plunger, C, is at the end of the downward stroke, and directly over the intake port, X, so that when the plunger is moved upward by the cam, K, and the lever, F, the oil is drawn into the cylinder, the quanity being determined by the position of the adjustable regulating rod, M, by means of which the charge of oil is increased or diminished, at the will of the operator. When fully lifted, the lever, F, rides upon the circular part of the cam, K, holding the plunger in a fixed position while

the cylinder, B, with its charge of oil is rocked by the cam, J, until the port, V, registers with the outlet, Y, at which point the cam, K, releases the lever, F, which is actively depressed by the spring, G, forcing the charge of oil through each of the series of delivery ports, R, to the various bearings, with which these ports are connected by means of suitable brass or copper tubes."

The advantages claimed for this pump by the manufacturers are the following:

"They measure the oil, and uniformly feed exact quanities to each bearing they serve, regardless of the resistance or the varying resistances in the different tubes."

"They .... will feed exact quanities of oil when run at show speed."

"They feed only when the machine is in motion."

"They do not leak oil, whether the machinery is running or standing still."

"They have no valves, and therefore their action cannot be interferred with by foreign substances in the oil."

"They will send the oil to any required height or distance."

"Their separate feeds are independently adjustable, and when any feed has once been set to.deliver a given amount of oil, it will deliver that exact amount at each discharge, until the position of the proper adjusting rod has been changed by the operator. The frequency of the delivery varies with

the varying speed of the motor. This enables the manufacturer of any machine to which this oiler is attached, to properly adjust the feeds before the machine leaves the factory, and the operator then has nothing to do except to see that the tank is supplied with oil."

"They begin to feed oil as soon as the motor starts, and continue to feed as long as the machinery is running . They stop when the motor stops."

"They always, with unerring certainty, perform the duty set for them; and the cannot be deranged or thrown out of adjustment."

"The great force they exert prevents obstructions of any kind lodging in the delivery tubes."

"When used in connection with splash lubrication, they will unfailingly maintain an absolute level in the crank case."

Figs. 22, 23, 24, 25, 26, represent another style of valveless pump.

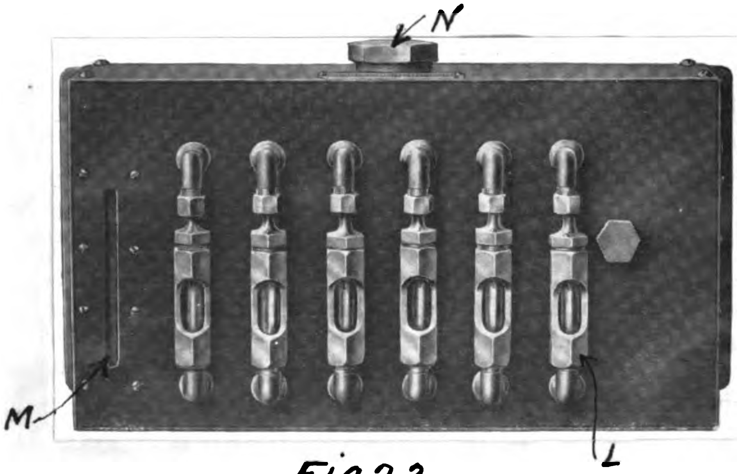


Fig 22.

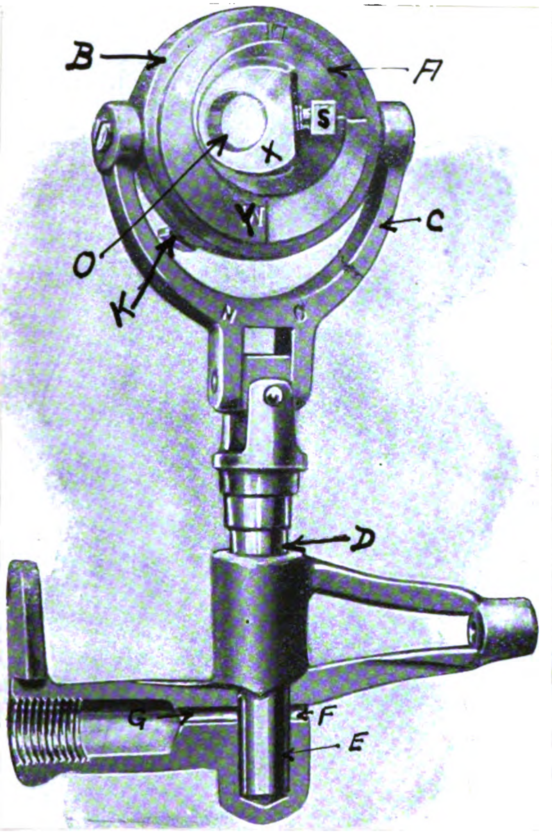


Fig. 23.

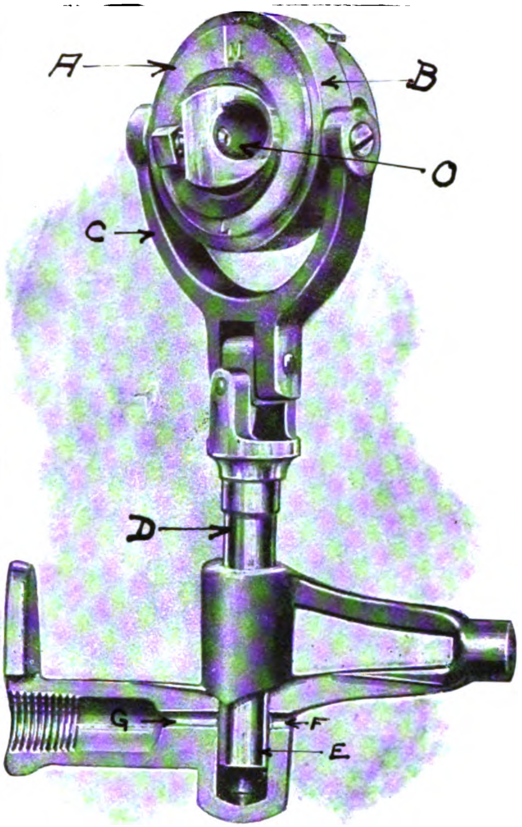


Fig. 24.

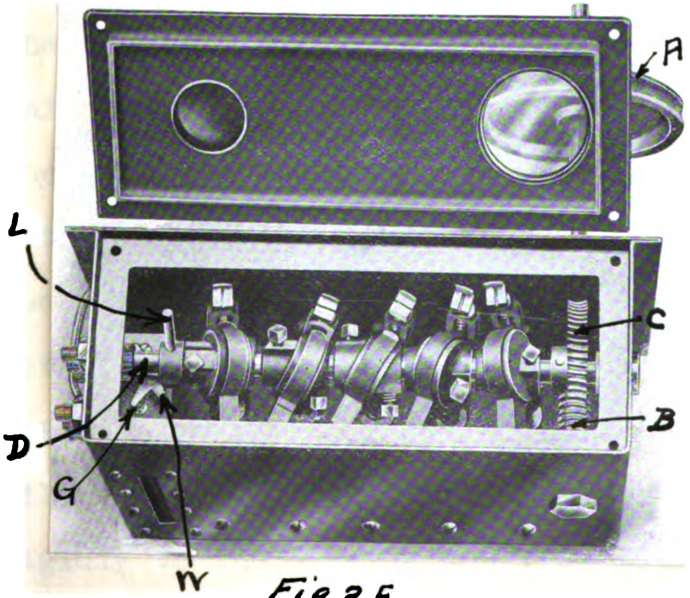


Fig. 25.

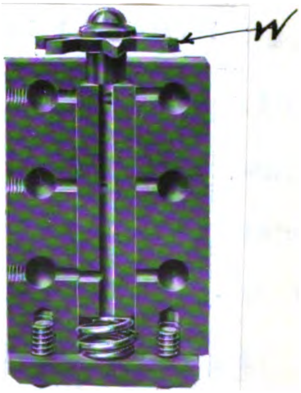


Fig. 26.

The principle on which this pump works is shown in Figs. 23 and 24. in which, A, represents an angular eccentric connected by means of the strap, B, and the yoke, C, to the plunger, D. The driving shaft passes through the hole, O, as may be seen in figure 23, and, on rotating, gives the plunger an up and down motion, and at the same time, a twisting motion. The plunger is slotted as may be seen at E. The intake port is shown at F and the discharge port at G. Fig. 23 shows the eccentric and the plunger at their extreme upward positions, and with intake port closed, and discharge port just about to open. As the shaft continues to rotate, the discharge port is completely opened and the plunger forced down, thus forcing the oil from beneath the plunger to the point of lubrication. When the plunger reaches the extreme point in its downward travel, the angularity of the eccentric causes it to turn, closing the discharge port, and opening the intake port, when the operation is repeated. Any number of feeds can be obtained by placing these pumps in series, as shown in Fig. 25. The adjustment of the length of the stroke, and hence of the amount of oil pumped to each point of lubrication, is brought about by means of the eccentric A, which is made of two separate eccentrics, one inside the other, so constructed that by rotating the one, the total eccentricity can be varied at will. In Fig. 23, X, is the inner eccentric, fastened rigidly to the driving shaft by means of the set screw, S; Y is the outer eccentric carrying the strap, B, and the yoke, C,

and rigidly fastened to X, by the set screw, K. The method of driving this lubricator is shown in Fig. 25, in which, A, represents a pulley, B, a worm meshing into the worm gear, C, which carries the driving shaft, D. The sight feed arrangement is shown in Fig. 22, at L, the oil gauge at M, and the filler plug at N. The pipes leading to the points of lubrication all come out of the back of the lubricator in this case.

One very marked advance which this lubricator embodies is in the distributor shown in Fig. 25 at G, and in section in Fig. 26. By means of this distributor, one pump is used to lubricate six bearings. Quoting directly from the manufacturers catalogue the working of this distributor is as follows:

"The tube from the pump, when it is connected, delivers the oil into the bottom of the hollow plunger, as illustrated, the plunger as shown being set for the left hand opening at the bottom. On the up stroke of the plunger a striker arm, as shown at L, in Fig. 25, turns the star wheel, W, turning the plunger, closing the last opening oiled, and opening the one on the right at the top. On the down stroke of the plunger this opening receives the charge of oil. On the next up stroke of the plunger the striker arm, L, again turns the star wheel, W, turning the plunger one sixth of a turn, opening the next opening below, and closing the last opening oiled, and so on until the six are oiled, when it starts over

again. The amount of oil delivered to these various parts is regulated by the throw of the plunger. You will not fail to note that there are no valves in any part of the connections, so that there is nothing to get out of order."

The lubricator shown in Fig. 22 is equipped to lubricate four cylinders and twelve bearings. It has a distributor in each end.

The advantages with this lubricator are the following:

Absence of valves.

Absence of springs.

Positive action of plunger in both directions.

Complete and accurate adjustment of individual feeds.

Ability to pump against enormous pressures. (These pumps are all required to work against a pressure of 1400 pounds per square inch before being placed in the lubricator.)

Ability to distribute oil from one pump to a large number of bearings.

Ability to handle different kinds of oil.

Ease of enlargement.

In describing the last three lubricators the cuts and views of the manufacturers have been used and their catalogues have been quoted from as far as possible. They have been shown as they are presented to the trade, and everything has been claimed for them which their manufacturers claim. A design is now presented which, it is believed, combines the good features of these three lubricators into a single one,

which is at once, simplier in design, cheaper to manufacture, and more efficent in its operation.

Part II.

Design of A Mechanical Lubricator.

Object of Design: The object in designing this lubricator has been to produce an oiler which combines the good qualities of the three types just described, at the same time, eliminating some of their faults. It has been an attempt to simplify the design, and to reduce the cost of manufacture, without sacrificing any of the essentials which go to make a perfect lubricator. Accordingly, the design has been made to fulfill the requirements laid down in Part I, namely: to make an oiler simple in construction, positive and reliable in its action, capable of being adjusted to work through a wide range, capable of supplying oil to six bearings or cylinders simultaneously, each being independent of the others, and all feeds being adjustable without stopping the oiler. Before entering upon this design a careful and complete examination of the patents on existing oilers has been made, and this machine so designed as to avoid any infringement.

Specifications: Referring to the accompanying drawings, the same letters of reference are employed in the different views to represent the corresponding parts. The oiler consists of the following essential parts, namely: A main casting, A, rectangular in shape, with lugs, 1, $1'$, on the sides to provide bearings for the driving shaft, S, and with a thick bottom, in which is formed the seat, v, v', for the cylinder disc, C, the intake port, i, and the discharge ports,

d, d', (a better view of intake and discharge ports is shown in Fig. 3;) a cylinder disc, C, in which are drilled intake and discharge ports to correspond to those in the main frame, Fig. 4; a plunger, D, working accurately in a cylinder formed concentrically in the cylinder disc, C; a cam, E, for giving said plunger a downward motion; a spring, F, for raising said plunger; a train of intermittent gears consisting of, G, H, fastened in any convenient manner to the cylinder disc, C, and to the driving shaft, S, respectively, for turning the cylinder disc as desired; a cover, I, carrying adjusting screws, J, with lock nuts, K, which together with the system, L, M, consisting respectively of a thin piece of steel with loose fitting holes, and pins, fastened conveniently into G, form a device for regulating each stroke of the plunger, D; a ratchet wheel, N, rigidly fastened to the driving shaft, S; an arm, O, bearing a dog, P, and a spring, Q, for operating said dog, for turning ratchet wheel; an auxiliary dog, R, Fig. 2, for preventing motion in the opposite direction; a washer, T, and a cotter pin, U, for holding arm, O, in place; a lost motion device, W, pivoted about the shaft, S, and held in any desired position by the screw, X; a plug, Y, which forms the bottom of the compression chamber; and the nipples, V, V', for attaching intake and discharge pipes.

The operation of the oiler is as follows: The arm, O, is attached to some reciprocating or eccentrically rotating part of the engine, in such a manner, that the arm, O, is

made to oscillate, thus giving the ratchet wheel, and consequently the shaft and what it carries, a counter-clockwise rotation. In the position shown in Fig. 1, the cam, E, and the plunger, D, are shown in their extreme downward positions, so that when the engine starts the cam, E, recedes, and the plunger, D, under the action of the spring, F, follows it. The plunger, D, in raising tends to produce a vacuum in the cylinder, which, being in communication with the oil chamber, through the intake port, i, fills with oil. As soon as the plunger, D, has reached the limit of its upward stroke, the gear, H, is so timed that one of its teeth comes into contact with a corresponding tooth on the gear, G, and causes gear, G, to turn through one twelfth of a revolution, thus carrying the cylinder disc, C, and closing the intake port, i, and opening one of the discharge ports, d. As soon as the tooth of the gear, H, has passed that of G, the gears are locked and the cylinder disc is held rigidly in place. At this point the cam, E, causes the plunger, D, to descend and force the oil out of the discharge pipe to the point of lubrication. On the next revolution of the driving shaft, the next bearing or cylinder receives its charge of oil, and so on, each bearing or cylinder getting every sixth discharge. Reference to Figs. 3 and 4 shows that all discharge ports are always closed, save the one being discharged into, thus obviating the use of ball or check valves of any description, and yet retaining constant pressure. The speed of the driving shaft

is adjustable partially by attaching to the engine at a or a′, according as greater or less speed is desired; and partially by means of the lost motion device, W. Fig. 2 shows the lost motion device in full operation. The dog, P, carries a projection, Z, which, riding upon the flange, W, holds the ratchet dog out of mesh with the ratchet wheel for any desired amount of the stroke. The adjustment of the plunger stroke to meet the needs of each individual cylinder or bearing, is brought about as follows: The steel plate, L, raises and lowers with the plunger, D, and turns with the gear, G. The adjusting screws, J, six in number, are placed in a circle, one for each point of lubrication, in such a way, that as the gear, G, turns, the plate, L, is brought under the screw corrosponding to the cylinder or bearing receiving the discharge. The adjustment once effected, the adjusting screws may be locked by the lock nuts, K, and the action of the pump may be depended upon.

This pump, like the three preceeding ones, has been designed particularly to meet the needs of the automobile trade, although it might be equally well applied to steam engines, or any other kind of machinery. When used as an automobile oiler, it is to be attached beneath the body of the automobile, as near as possible to the engine. It is not a dash pump; nor has it been designed with any intention of having it in sight, because of the fact, that dash pumps are always more or less greasy, and dirty, and therefore, very

objectionable, especially to men and women who operate their own cars. In order that the operator may know at any instant that his oiler is working properly, the oil is drawn through a sight feed on the dash, into the pump, and from thence, forced to the point of lubrication. Unlike the foregoing designs, this oiler is not designed to pump oil from its own. chamber, although it may be used in that way, but rather to pump oil from a large receptacle, placed at any convenient point on the machine. The pump may thus be placed in an extremely small place, and its chamber filled with oil, which insures lubrication of all its working parts without any attention on the part of the operator. While the drawings shown illustrate an oiler capable of supplying only six points of lubrication, and capable of using only one kind of oil, it is at once evident that by increasing the size of the cylinder disc, the number of feeds can be increased indefinitely, and also by increasing the number of discs and plungers, with their operating mechanisms, any number of different kinds of oil can be used.

Claims: The advantages which are claimed for this design of lubricator are the following:

Simplicity of design, and low cost of manufacture.

Absence of screws and packed joints.

Absence of valves of any description, thus obviating the necessity of straining the oil.

Complete and accurate regulation of each individual

discharge from the outside of the pump, without opening the oiler or stopping the engine.

Positive operation.

Tendency of wear of cylinder disc to increase rather than decrease efficency of oiler. This is true because the joint at v, v', is ground and the continual wear, small though it is, has a tendency to improve the fit of the cylinder disc on its seat.

Tendency of pressure created in forcing oil, to hold cylinder disc onto its seat, rather than forcing it off.

One plunger does the work of six, thus combining the advantages of a pump and a distributor in one mechanism.

Ease of enlargement and duplication.

Ability of handling different kinds of oil simultaneously.

Ability to pump oil from a receptacle at a distance, thus preventing constant filling.

Compactness of design, enabling oiler to be attached at any point without inconvenience to the operator.

The advantages of this type of oiler will be still more forcibly seen upon an examination of the cost of manufacture.

An estimate of the cost of manufacture is found on pages 56 & 57 at the end of this work.

Estimate of Cost of Manufacture: In estimating the cost of manufacture of this lubricator, it has been found advisable to make all computations and estimates on the basis of one thousand. The reason for this is, that the cost of patterns, core boxes, jigs and special tools is distributed and is made to enter into the final cost in about its proper proportion. Farthermore, most of the material can be purchased cheaper in large lots than in small ones, and the shop work on a quanity can be done cheaper than on a single one. Prices on iron castings were obtained from a local dealer, (4 ¢ per pound). Prices on screws, springs, fittings, and so forth were taken largely from Strelinger's catalogue, allowing for the customary discount.

In estimating the cost of work previous to assembling, the work has been divided up into four classes, namely: lathe, drill press, automatic machine, and miscellaneous. Lathe and drill press men have been figured at $1.50 per day, and automatic machine at $2.50 per day. Miscellaneous work includes grinding, filing, tapping, and so forth, and is estimated accordingly. Paint boy's wages have been figured at 75¢ per day, packing man's wages at $1.50 per day, and men doing assembling at $2.00 per day.

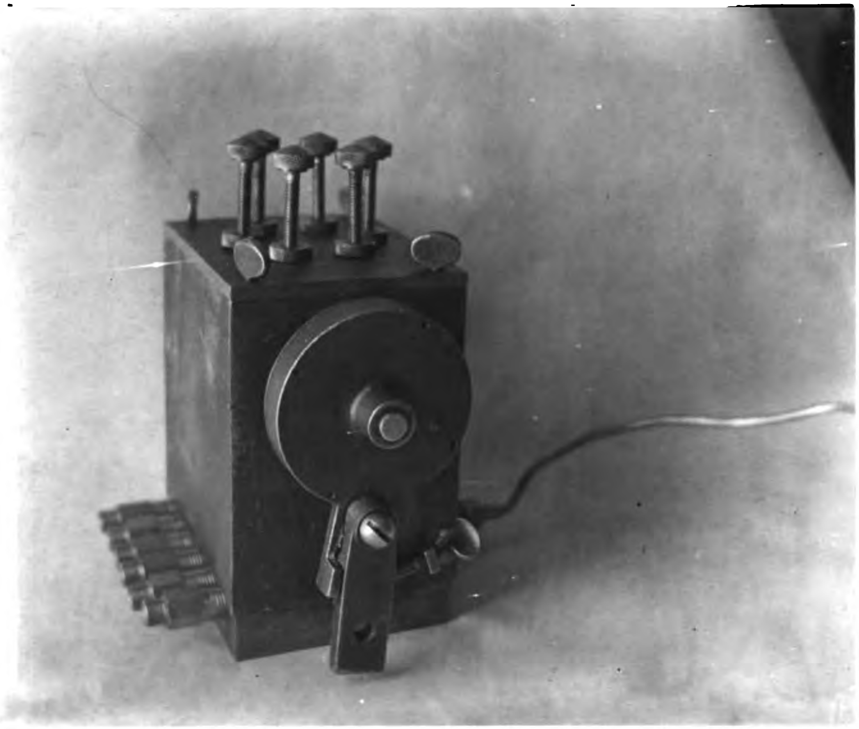
The estimates based on experience are largely approximations to results which were obtained by keeping strict account of the cost of manufacture of a very similar class of goods.

Results of tests: Following the design and specifications alid down at the beginning of this chapter, an oiler was built and assembled, see cuts pages32 . Operating, it worked precisely as had been calculated, delivering oil from each feed in turn. So far as the design is concerned the results obtained from the test were entirely satisfactory. Owing, however, to amateur workmanship, and to the difficulties which necessarily attend the first construction of any machine, the efficency of this oiler was very low. By efficency in this case is meant ability to pump oil against pressure. Accurately machined, with the aid of jigs and special tools, there is no doubt but that perfectly satisfactory results can be obtained.

Tests of the lubricator described on page20 were also made, in which case, it was found that pressures from 1400 pounds per square inch to 2000 pounds per square inch were easily obtained on slow speed. The slip of the pump was found to be practically nil. The operation of the distributor, and of the pump generally, during the test was all that the manufacturers claimed for it.

General Conclusions: The conclusions here drawn are based upon such results and reports as are obtainable from the automobile trade.

The first of the automatic high pressure pumps described is manufactured by McCord & Co. of Chicago, Ill. Its good qualities have been fully enumerated in the



paragraphs quoted from the manufacturer's catalogue. From a practical standpoint, it lacks one of the essentials of a good oiler, namely, it is not a valveless pump. The ball valves used necessitates a filtering of the oil in order that no particles of grit or dirt get under the balls and prevent their proper seating. The filling aperature is small and partially closed by the filling gauze, thus rendering the filling very slow. The plunger works through packed joints thus increasing friction and wear. The lubricator is driven by a worm and worm gear, the small angularity, and the high speed of which, necessarily make them short lived.

The second lubricator described is that built by the Steel Ball Co. of Chicago, Ill. It is called the "Hill Precision Oiler". The great objection to this pump is the fact that on the discharge stroke the plunger is actuated by a spring. A plunger actuated in either direction by a spring is objectionable because of the loose fit which the plunger must have in order that the spring may cause it to operate. Type B Fig.21 is open to the same objection as the McCord pump in the matter of being driven by a worm and gear. The arrangement of the discharge pipes Fig. 21 is not as convenient as it should be. Barring these objections, however, this is doubtless the most satisfactory lubricator accessible to the automobile trade at the present time.

During the month of February, 1906, the writer attended the automobile show at Chicago, Ill. with the express motive

of examining the various methods of automobile lubrication. It was noted, at that time, that the highest grade of cars not using their own make of lubricator were equipped with the "Hill Precision" oiler. Farthermore, there were more "Hill Precision" oilers on the cars than all other makes combined, a fact which testifies most accurately the attitude of the automobile trade to this particular lubricator.

The last of the three lubricators described as being typical of the automatic pressure pump type is manufactured by the Madison-Kipp Lubricator Co. of Madison, Wis. While it comes nearer than either of the other two to fulfulling the requirements laid down in Part I for a good lubricator, it is very complex and contains a very large number of parts Fig.25 . The large number of holes through the sheet metal body are difficult to keep from leaking. Also the number of joints and wearing parts is large. Once taken apart, it requires an expert to put it in running condition again. It is likewise open to the worm and worm gear objection charged against the other two. While there is no doubt that the principles on which this pump operates are more advanced than the principles of either of the other two, they have not been, as yet, put into the best mechanical form.

All that can be definitely said about the design presented herein, is, that it can be built and made to work. So much has already been done. Before being practical, the efficency must be increased, and that can be done by accurate

workmanship. The design is weak in that it employs a spring for raising the plunger. That objection obviated by using some positive adjusting device, this oiler must necessarily represent an advance in the art of lubrication.

List of Patents Examined: Before entering a list of the patents examined, the writer wishes to acknowledge the suggestions and aid of Mr. W. E. Parr, Superintendent of the Madison-Kipp Lubricator Co., whose interest and enthusiasm have been instrumental in bringing out the design presented.

Following is a list of the patents with name and number of patent and name of patentee. These patents refer not only to mechanical lubricators but to lubricators of all descriptions. To make the work complete, everything pretaining to Lubrication under the general heads "Lubrication", "Oil", and "Pump" have been entered. Such oilers as are listed under different heads have been entered as far as possible. The list is complete from Jan. 1, 1902 to May 1, 1908.

Date.	Patentee.	Invention.	Number.
Jan. '02.	Ritter H.	Lubricator	691750
	James T.S.	Lubricator	691632
	Blevney J.C.	Piston Lubricator	690510
	Swisher J.	Oil Can	692089
	Montgomery W.G.	Oil Cup	692186
	Clements W.G.	Oiler	691338
	Lofdahl A.	Lubricating device	701364
	Hamelle H.	Lubricating App.	691905
	McCanna J.F.	Lubricating Pump	691478
	Rateau & Sautter	Lub'ng Steam Turb.	691914
Feb. '02.	Taylor M.W.	Lubricating device	692558
	Walker J.B.	Hand Oiler	693341
	Naufits G.A.	Oil Feed Cup	693734
Mar. '02.	Ruff W.J.	Lubricating App.	696197
	McCanna & Delaney	Lubricator	694406
	Fisher G.	Lubricator	695603
	Weir W.S.	Oil Can	695512
	Wall & Moore	Oil Can	696384
	Bocorselski F.E.	Oil Cup	694605
Apr. '02.	Schmidt J.	Lubricating Can	696501
	Archer G.B.	Oil Can	699059
	Hanson B.M.W.	Oil Cup	697082
	Strong W.E.S.	Oil Cup	697109
	Strong W.E.S.	Oil Cup	697110

Date.	Patentee.	Invention.	Number.
Apr. '02.	Alden A.M.	Oiler	697700
May '02.	Gill J.E.	Journal Lubricator	701029
	West L.G.M.	Lubricating Device	700270
	Kipp O.G.	Lubricator	699191
	Gill J.E.	Axle Lubricator	701030
	Lane W.J. & G.	Engine Lubricator	699688
	DeLapp F.M.	Track Lubricator	699747
June '02.	Lofdahl A.	Lubricating Device	701364
	Harris H.	Lubricator	701567
	Lyddon H.A.	Lubricator	701745
	Tunney J.J. (Reissue)	Lubricator	12002
	Paul W.J.	Oil Can	702070
	McKenzie J.B.L.	Oil Cup	702068
	Nilson L.G.	Oil Feeder	702815
July '02.	Locke B.H.	Lubricating Device	704555
	Gottbreht J.	Lubricator	703403
	Pfounder J.M.	Lubricator	705608
	Freeman A.A.	Aut. Lubricator	704021
	Gowan R.H.	Axle Lubricator	704028
	Scobee C.S.	Pulley Lubricator	703838
	Smealey D.W.	Axle Lubricator	703488
	Quimm J.C.	Oil Feeder	703824
Aug. '02.	Richards W.F.	Lubricator	706201
	Edwards F.W.	Lubricator	706244
	Kipp O.G.	Lubricator	706570

Date.	Patentee	Invention	Number.
Aug. '02.	Loree P.E.	Trolley Lubricator	707338
	Laban P.F.	Valve Lubricator	706963
Sept. '02.	Reist H.G.	Lubricating Device	708170
	Duncan F.B.	Lubricating Device	708324
	Loesewitz J.	Lubricating Pad	709604
	Ivor B.	Lubricating Pump	709986
	Cartlidge F.	Lubricator	708022
	Clements C.F.	Lubricant Dispenser	710184
	Halloran M.H.	Lubricator	709318
	Weiss C.W.	Engine Lubricator	710026
	Bradford J.A.	Truck Lubricator	708306
	Schmidt H.	Pneu. Lubricator	708448
	Bruzek A.	Pump Automatic	709662
	Elliott R.W.	Pump Pneumatic	709212
	Word D.C.	Pump Valve	708508
Oct. '02.	Logan L.L.	Bearing Lubricator	710481
	Newton G.W.	Car Wheel Lubricator	710709
	Winton A.	Oil Feeder	710928
	Kraushaar G.J.	Oiler	711114
	Deare & Leckner	Lubricator	711295
	Fleming J.R.	Axle Lubricator	710677
	Brown B.R.	Gravity Feed Lubr.	712254
Nov. '02.	Abbott J.	Lubricating Axles	714123
	Wardwell S.W.	Lubricating Device	712745
	Elvin A.G.	Lubricating Device	714410

Date.	Patantee.	Invention.	Number.
Nov. '02.	Mittag C.	Lubricating Device	714007
	Rampazzi E.L.	Lubricator Cup	714329
	Armstrong E.	Oiler Car	714272
	Hatt C.E.	Oiling Device	714439
	Thurston G.W.	Oiling Device	714337
Dec. '02.	Norris A.E.	Lubricator	714941
	Whitaker G.	Lubricator	715717
	Webster G.S.	Lubricator Choke	715913
	Scott S.W.	Oiling Apparatus	716292
Jan. '03.	Matthews T.A.	Lubricating Box	719021
	Hawkins F.L.	Lubricating Device	718456
	Copper W.C.	Oiler Air Pump	717547
	Walker R.S.	Oiler Car	718039
	Fishell P.H.	Oiler vehicle	718443
Feb. '03.	Hansen M.B.	Lubricating App.	719941
	Taylor C.L.	Lubricating Box	721252
	Hanson & Williams	Lubricating Device	720026
	Lucas A.F.	Lubricator	721057
	Michalk W.	Lubricating Press	720047
	Weiseckel G.	Lubricator	720067
	Calion L.P.	Lubricator	721284
	Morningstar H.	Engine Lubricator	720516
	Essex G.B.	Pump Lubricator	719836
	Enos C.W.	Pump Oil	720121
	Hirsch C.	Pump Oil	720251

Date.	Patantee.	Invention.	Number.
Mar. '03.	Christensen N.A.	Lubricating Mech.	722209
	Swenson J.A.	Lubricator Aut.	722769
	Luhr & Andersen	Engine Lubricator	723290
	McClure J.W.	Pump Oil	722184
Apr. '03.	Davis E.E.	Lubricator	725545
	Peacock G.J.	Oiler	724493
May '03.	Walters L.	Lubricator	728146
	Full G.C.	Engine Lubricator	728698
	Smith J.G.	Journal Lubricator	728777
June '03.	Macloski G.	Lubricating Device	730813
	Campbell & Berg	Lubricating Device	730813
	Campbell & Berg	Lubricating Device	730814
	Brush A.P.	Lubricating System	730738
	Schneider G.	Lubricator	730482
	Mougette E.J.	Lubricator	730784
	Allen & Carver	Lubricator	731731
	Allen & Carver	Lubricator	731833
	Walker J.H.	Lubricator	732146
	Payser & Bowen	Journal Lubricator	732318
	Wilson G.	Oiler	730065
	Buffam H.H.	Oiler Piston	729537
	Chapman L.S.	Pump Valveless	732169
July '03.	Strapp J.M.	Lubricating Cup	734443
	Elvin A.G.	Lubricating Device	12134
	Fisher & Krosli	Lubricator	733179

Date.	Patentee.	Invention.	Number.
July '03.	Freeman A.A.	Lubricator Aut.	733382
	McGill M.J.	Cable Lubricator	733255
	Ivor & Ward	Lubr. Force Feed	734069
	Bennett T.B.	Axle Oiler	733420
	Philpott T.S.	Oiler	734036
	Price A.C.	Pump Rod Adjuster	733505
Aug. '03.	Forrer J.D.	Lubricating Device	736376
	James H.	Lubricator	736263
	Claghorn C.R.	Axle Lubricator	736689
	Claghorn C.R.	Axle Lubricator	736819
	Cain F.C.	Pumping Apparatus	737336
	Robertson F.L.	Pumping Device	736549
Sept. '03.	Lewis J.F.	Lubricator	738046
	Mellings & Gay	Lubricator	738835
	Dalrymple J.C.	Oiler Gun Barrel	739653
	Baker Shelvin & Baker	Oiling Device	738513
	Thurston G.W.	Oiling Device	739745
Oct. '03.	Friedmann L.	Lubricating App.	741478
	Erickson & Young	Lubricator	740409
	Hoffman C.L.	Lubricator	740856
	Peavey W.S.	Lubricator	734484
	Langdon P.J.	Axle Lubricator	742041
	Stare B.R.	Journal Lubricator	740482
	Buzenberg & Lange	Journal Lubricator	740525
	White T.J.	Oil Distb. App.	741862

Date.	Patentee.	Invention.	Number.
Oct. '03.	Allen G.T.	Oiler	741432
	Paulson B.	Oiler Automatic	740992
	Brown R.B.	Shaft Oiler	742579
	Bradford & Gordon	Pump Oil	740738
Nov. '03.	Michalk W.	Lubricating	744088
	Fisher H.W.	Lubricator	743849
	May F.X.	Lubricator	744927
	Lockwood P.J.	Lubricator	743392
	Peilicke R.	Graphite Lubr.	744101
	Sarver E.	Locomotive Lubr.	744625
	Henew N.P.	Oiler Automatic	743371
Dec. '03.	Oldendorph J.	Lubricating Device	746874
	Gibbons J.A.	Lubricating Device	748362
	Renault L.	Lubricating Device	747767
	Johnson A.	Lubricating Ball	748191
	Hanson B.M.W.	Lubricator	745434
	Burwell H.S.	Lubricator	745567
	Schurman & Whited	Lubricator	746883
	Fishbough H.E.	Lubricator	747875
	Clifton A.E.	Lubricator	748480
	Homard A.D.	Graphite Lubr.	746837
	Bartow G.C.	Oil Gauge	747032
Jan. '04.	Delaney T.A.	Lubricator	749477
	Hall S.M.	Lubricator	750053
	Chapman L.	Lubricator	750751

Date.	Patentee.	Invention.	Number.
Jan. '04.	Henderson T.M.	Pump Lubricator	748731
	Peart A.A.	Axle Lubricator	748881
	Burke S.E.	Oiler Wind Mill	749526
Feb. '04.	Matthews T.A.	Lubricating Device	753201
	Krebs A.	Motor Lubricator	752566
	Dettmar G.	Testing Lubricants	752827
	Leach J.M.	Lubricator	751186
	Hodges C.B. & F.W.	Lubricator	752554
	Launer C.	Axle Lubricator	752625
	Fleming J.R.	Axle Lubricator	752897
Mar. '04.	Schneider G.	Lubricator	755802
	Ludendorf H.	Lubricator	755898
	Edwards F.W.	Sight Feed Lubr.	755120
	Steue C.J.	Axle Lubricator	755957
	Morrow O.A.	Mech. Movement.	756131
	McKenna & Markel	Lubricating Pump	754485
	Hawkins F.L.	Lubricating Device	12209
	Campbell B.F.	Lubricating Device	775741
	McKenna J.F.	Lubricating App.	754486
	Maingault W.P.	Lubricating Device	756126
	Graham J.C.	Lubricating Device	756126
	Aull J.J.	Lubricator	754737
	Collinson F.J.	Lubricator	754972
	Riegels O.A.	Lubricator	755245
Apr. '04.	Robinson C.	Oil Pump	757499

Date.	Patentee.	Invention.	Number.
Apr. '04.	Reed E.C.	Needle Lubricator	758473
	Roberts D.H.	Sight Feed Lubr.	756286
	Malcom W.R.	Lubricator	756867
	McCune G.C.	Lubricating Pump	758460
May '04.	Galsrud C.G.	Lubricator	758640
	Dyington A.	Lubricator	759860
	Erbor A.	Lubricator	760439
	Kinch H.L.	Lubricator	760876
	Sullivan C.A.	Lubricating valve	761425
June '04.	Elvin A.G.	Lubricating Device	763599
	Lefebvre C.E.	Lubricating System	763681
	Gay O.E.	Lubricator	762701
	West C.P.	Motion Feed Lubr.	762967
	Bird M.O.	Rail Lubricator	763537
July '04.	Gill J.E.	Lubricating Device	765176
	Donnenworth J.G.	Lubricator	764886
	Jacobson C. & J.	Lubricator	765387
	Boyer J.	Lubricator	764786
	Weaver A.	Journal Lubricator	764021
Aug. '04.	George E. Jr.	Pump Diaphragm	768984
	Aitken J.	Pump Rotary	12259
	Snowdon J.	Lubricator Aut.	768958
	Baird E.W.	Lubricating App.	768840
	Potter W.B.	Lubricating Device	766382
	Rix E.A.	Lubricating Device	768820

Date.	Patentee.	Invention.	Number.
Aug. '04.	Chapman L.	Lubricator	766756
	Essex G.B.	Lubricator	767047
	King C.B.	Lubricator	768529
	Alexander W.	Lubricator	790040
	Ferris & Rousseau	Oiling Device	768038
Sept. '04.	Bickel H.J.	Lubricator	769206
	Puerner A.G.	Lubricator	769632
	Fortni J.H.A.	Lubricator	771052
	Godley G.F.	Journal Lubricator	770684
	Burdick	Lubricator Vehicle	769786
	Krishman	Oil Feeder	770077
Oct. '04.	Murphy L.E.	Lubricator	772954
	Joy J.F.	Lubricating Device	772153
	Richards W.J.	Lubricating App.	773523
	Clark E.	Lubricator	771711
	Deuster & Maschmeyer	Lubricator	771815
	McClure	Lubricator	771882
	Hauek & Rose	Lubricator	772145
	Bowen G.W.	Lubricator	772399
	Annon G.H.	Lubricator	773181
	Pearson W.B.	Crank Pin Lubr.	771571
	Kelsey B.F.	Cylinder Lubricator	772240
	Moser G.W.	Force Feed Lubr.	772427
	Brennan G.T.	Journal Lubricator	771411
	Dial & Diamond	Sewing Machine Lubr.	772502

Date	Patentee.	Invention.	Number.
Oct. '04.	Tasch H.H.	Wind Mill Lubr.	772187
	Winkenwerder H.	Force Feed Lubr.	773446
	Pero G.W.	Journal Lubr.	771444
Nov. '04.	Hammelle H.	Lubricating App.	776240
	Borland M.H.	Lubricating Cup	773538
	Blynt & Clark	Lubricator	773545
	Wilson J.F.	Lubricator	774015
	Dolphin M.F.	Lubricator	774050
	Walsh G.	Lubricator	774960
	Laquay	Lubricator	776188
	Powell J.	Lubricator	776422
	Kenwick & Rupple	Lubricating Guard	776331
	Farley J.	Lubricator Aut.	775673
	Elgen M.P.	Lubricator Aut.	776308
	Fletcher F.A.	Axle Lubricator	773557
	Young E.	Saw Lubricator	776448
	Godley G.F.	Oiler	773790
	Messelbach A.F. & W.	Oiler Pocket	774328
	Nugent W.W.	Oiling Device	774969
	Palner S.A.	Oiling Device	774270
	McKenne & Markle	Lubricating Pump	775067
	Mason W.B.	Pump Oil	775982
	Maginot A.	Pump Centrifugal	773953
Dec. '04.	Campbell & Berg	Lubricating Device	777596
	Miner J.H.	Lubricating Device	777428

Date.	Patentee.	Invention.	Number.
Dec. '04.	Forse S.B.	Lubricator	776900
	Thomilson & Starr	Lubricator	778087
	Place J.A.	Lubricator	778265
	Meehan J.	Lubricator Aut.	777120
	Allen C.B.	Lubricator Cylinder	777765
	Solan & Robinson	Oiler Trolley	776871
	Frisbe D.D.	Oiling Apparatus	778824
	Haynes E.	Lubricating Pump	777413
Jan. '05.	Clark & Blynt	Oil Pump	779689
	McCarthy F.	Lubricating Att.	780953
	Comstock C.	Lubricator	780778
	Comstock C.	Lubricator	780779
	Tismer P.G.	Oiling Device	780839
	Thompson W.H. & R.	Lubricator	781111
	Ritter H.	Lubricator	781553
	Aull J.J.	Lubricator	781584
	Aull J.J.	Lubricator	781585
	Youstey W.H.	Lubricant Dist'b'r	780254
	de Rijk W.J.F.	Lubricating	779315
	Byrd & Travis	Lubricator	779026
	Hart F.J.	Lubricator	779039
	Morris & McClair	Oil Can	779299
	Wilkinson W.H.	Oil Cup	779336
	Gardner L.S.	Lubricating Device	779690
	Clark J.V.	Lubricating Device	779357

Date.	Patentee.	Invention.	Number.
Jan. '05.	Knipper & MacKaye	Lubricator	779609
	Marven E.D.	Lubricator	779792
	Palm G.	Oil Can	779798
	McGinty & HMber.	Oil Cup	779959
Feb. '05.	Berger E.	Lubricator	781804
	Lockwood P.J.	Lubricator	781891
	Thurston G.W.	Lubricator	782532
	Walcott & Davidson	Lubricator	782734
	Eichenser W.R.	Lubricator	782590
	Elkins R.H.	Lubricating Machine	782225
	Epperson C.W.	Oil Can	782736
	Roebing K.G.	Oiling Device	782276
	Clarke L.S.	Lubricating Device	783020
	Eurico G.	Lubricator	783112
	Trotter J.	Lubricator	783159
	McCoy F.	Journal Lubricator	783382
	Baker J.M.	Oil Can	783237
	Willis & O'Connel	Oil Feeder	783343
	Sturtevant T.	Oil Pump	783392
	Mougette E.J.	Lubricator	783753
	Bryant, Davidson & Walcott	Sight Feed Lubr.	783718
	Bryant, Davidson & Walcott	Oiler	783717
	Huff W.A.	Oiling Device	783598

Date.	Patentee.	Invention.	Number.
Mar. '05.	Sherman W.S.	Oil Pump	786167
	Hultquist C.	Lubricator	784049
	Royle V.	Oil Cup	784280
	MacBain D.B.	Lubricator	784953
	Gustafson C.J.	Force Feed Lubr.	784788
	Trotter J.	Lubricator	785452
	Galsrud C.G.	Lubricator	785606
	Vandenburgh W.	Axle Lubricator	785242
	Hayward J.C.	Oiler	785612
	Pape W.H.	Lubricator	785826
	Wood G.A.	Oil Cup	786185
Apr. '05.	Hanson J.	Lubricator	786357
	Flinn R.J.	Lubricator	786637
	Williams D.B.	Lubricator	786701
	Williams D.B.	Lubricator	786702
	Callahan C.	Lubricator	786871
	Denegre E.	Lubricator	787155
	Alden J.	Axle Lubricator	787255
	Young F.J.	Oil Pump	786937
	Griffin W.B.	Lubricating Block	787752
	Eckhart F.E.	Lubricator	787567
	Allmond C.H.	Lubricator	787654
	Preece R.J.	Oil Cup	787466
	Knecht J.	Oiler	787848
	Gill J.E.	Lubricator	787915

Date.	Patentee.	Invention.	Number.
Apr. '05.	Comstock C.	Lubricator	788095
	Eggler C.H.	Lubricator	787978
May '05.	Stock O.B.	Lubricator	791054
	Davis T.	Lubricator	791084
	Hatcher W.A.	Lubricator	791418
	Nelson R.	Oiling Device	791360
	McQuead J.	Lubricator	789101
	Elliott R.J.	Lubricator	789268
	Jewson W.G.	Oil Pump	789430
	Lichter R.	Lubricator	789923
	Burns J.E.	Force Feed Lubr.	789960
	Hammelle H.	Lubricating App.	790498
	Davis & Shellagbarger	Oil Pump	790786
	Davis & Shellagbarger	Oil Pump	790787
June '05.	Miner J.H.	Lubricating Device	791640
	Hocks G.	Lubricator	791621
	Swift F.G.	Lubricator	791838
	Einfeldt E.	Lubricator	791888
	Jameson W.A.	Axle Lubricator	791697
	Ivor & Ward	Sight Feed Lubr.	791696
	Manzel	Oil Pump	791636
	Farwell F.O.	Lubricator	792253
	Moore E.G.	Oil Cup	792060
	Maize F.P.	Oiler	792412
	Gray A.A.	Oiler	792432

Date.	Patentee.	Invention.	Number.
June '05.	Edwards F.W.	Sight Feed Lubr.	792765
	Edwards F.W.	Sight Feed Lubr.	792764
	Dain F.	Lubricator	793499
	Baird E.W.	Lubricator Aut.	793264
July '05.	Ward F.G.	Lubricator	793699
	Wright A.B.	Lubricator	793915
	Pero G.W.	Axle Lubricator	793779
	Featherstone W.B.	Lubricator	794167
	Kipp O.G.	Lubricator	12373
	Malborg C.E.	Lubricator	795230
	Siebert E.L.	Lubricator	795455
Aug. '05.	Crasby O.	Lubricating Device	795898
	Josewski H.P.	Lubricator	795125
	Henry & Sneed	Lubricator	796511
	Lester J.W.	Lubricator	796586
	Kipp O.G.	Lubricator	796659
	Ivor & Ward	Sight Feed Lubr.	796793
	Casler H.	Lubricator	797046
	VanWinkle D.	Lubricator	797159
	Ewing W.F.	Lubricator Car	797188
	McCord A.C.	Lubricator	797742
	Rendel I.A.	Lubricator	797867
	Buckley & Sherry	Lubricator	798009
	Elmore H.G.	Lubricator Cylinder	797984
	Swenson J.A.	Lubricator	798083

Date.	Patentee.	Invention.	Number.
Sept. '05.	Elkins R.H.	Lubricator	799161
	Smith F.W.	Lubricator	799274
	Meely E.	Lubricating Pump	799574
	Weiss C.W.	Lubricator Graphite	800191
Oct. '05.	Reinker C.	Oiling Device	803133
	Swoyer J.C.	Lubricator	803370
	Taylor W.J.	Lubricator	802535
	Morehouse D.	Lubricator	802581
	Markel J.R.	Lubricator	802008
	Behnke A.R.	Lubricator	802072
	Lauffer & Gallagher	Oiler	802298
	Mears R.S.	Lubricating Device	801670
	Lofton H.M.	Lubricator	801730
	Conradson P.H.	Journal Lubricator	801300
	Mames L.B.	Lubricator	803182
	Lowry F.	Lubricator	803296
	Lowry F.	Lubricator	803297
Nov. '05.	Smith W.M.	Engine Lubricator	806014
	Davis J.B.	Oil Pump	805530
	Treat C.H.	Lubricating System	804988
	Featherstone W.B.	Lubricating System	804937
	Heck & Summons	Lubricator	804948
	Comstock C.	Lubricating Comp.	804455
	Campbell & Coates	Lubricating Device	805337
	Brown G.W.	Lubricator	804203

Date.	Patentee.	Invention.	Number.
Nov. '05.	Comstock C.	Lubricator	804454
	Lythe & Cawley	Lubricator	804612
	Gleason L.	Oil Cup	804655
	Hobart L.C.	Pulley Lubricator	804722
	Leidecker F.W.	Lubricator	803609
	Pedersen J.F.	Lubricator	804033
	Howland W.L.	Oiler	804009
Dec. '05.	Decker W.H.	Lubricator Aut.	808197
	Morse T.F.	Lubricator	807848
	Trotter J.	Lubricator	807883
	Dodge J.M.	Lubricator	807731
	Alden R.	Oiler	807985
	Tunstall W.	Lubricator	807406
	Nerbovig H.H.	Oiler	806988
	Fridgen J.	Lubricator	806130
	Matteson A.L.	Lubricator	806421
	Shulz W.C.	Lubricator Att.	806198
	Anderson F.	Lubricator Att.	806514
	Daniels W.H.	Journal Lubricator	806242
	Rhoades B.A.	Oiling Device	806498
Jan. '06.	Patterson W.S.	Lubricator	809393
	Johnson L.A.B.	Plunger Lubricator	809809
	Patterson T.S.	Shaft Lubricator	809740
	Dietz E.	Lubricator	810194
	Crawford L.O.	Lubricator	810844

Date.	Patentee.	Invention.	Number.
Jan. '06.	Copper J.	Automatic Oiler	810621
	Taylor A.H.	Automatic Oiler	810686
	Hams W.B.	Oil Pump	810532
	Baird & Durkin	Lubricator	811024
	Thompson & Sharman	Lubricator	810999
	Garretson F.B.	Oilers	811051
Feb. '06.	Dodge C.C.	Lubricator	812261
	Dodge C.C.	Lubricator	812330
	Kittleson O.O.	Lubricator	812428
	Maloy & White	Lubricator	812578
	Dohse E.H.	Lubricator	812644
	Driver C.H.	Axle Lubricator	812552
	Powell J.	Oil Cup	812362
	Sellers O.Q.	Lubricating Wheel	812887
	Hodges C.B. & F.W.	Lubricator	12454
	Joy J.F.	Car Lubricator	813214
	Berry A.	Journal Lubricator	812915
	Shoenborn G.C.	Oil Cup	813591
	Barnes J.B.	Lubricator	813398
	Boyd W.M.	Lubricating Device	811615
	Lovejoy G.W.	Lubricating Device	811858
	Henson J.	Lubricator	811917
	Ficks J.C.	Lubricator	812032
	Smith M.	Oil Cup	811801
	Kehoe T.J.	Oiling Device	811640

Date.	Patentee.	Invention.	Number.
Feb. '06.	Bronder G.A.	Lubricating Device	812402
	Mulhrad J.	Lubricating Pipe	812352
Mar. '06.	Mooney E.	Lubricating	814152
	Bryant, Wolcott & Davidson	Lubricator	814016
	Rutz C.	Lubricator	814082
	LeMassurier F.C.	Lubricator	814147
	Brown H.J.	Lubricator	814269
	Wilcox A.E.	Oiler	814104
	Gunn & Romberger	Oiling Tracks	814371
	Bronder G.A.	Lubricating Device	815260
	Gleason L.	Lubricator	815088
	Manzel C.W.	Force Feed Lubr.	815301
	LeFever E.	Axle Lubricator	815842
	Briet M.	Mechanical Lubr.	815508
	Randall F.J.	Lubricating Device	816253
Apr. '06.	Delauney & Belleville	Lubricating Device	817629
	Sloan G.	Lubricator	817529
	Delauney & Belleville	Oil Pump	817630
	Elliott H.W.	Lubricating Sysyem	818364
	Graebing C.E.	Lubricator	818160
	Elvin A.G.	Axle Lubricator	818021
	Hancock E.W.	Journal Lubricator	818373
	Love·A.C.	Car Lubricator	818384
	Elbin A.G.	Axle Lubricator	818022

Estimate of Cost of Manufacture:

Piece	Symbol	Material	Weight	Cost Raw	Cost Lathe	Cost Drill Pr	Cost Aut Mch.	Cost Misc	Cost 1000	Basis of Est.
Wood Patterns	—	Wood	1#	$1.00	—	—	—	$7.50	$8.50	Time
Metal "	—	Brass	25	5.00	—	—	—	10.00	15.00	Experience
Jigs	—	C.I.	40	1.60	—	—	—	25.00	26.60	"
Spc. Tools	—	Steel	3	.30	—	—	—	8.00	8.30	"
Main Frame	A	C.I.	11	.44	.01	.0075	—	.25	707.50	"
Cover	I	C.I.	1	.04	—	.00125	—	.00125	4.25	"
Rat. Wheel	N	C.I.	1/4	.01	.015	—	.08	—	91.50	"
Rat. Arm	O	C.I.	1/4	.01	—	.02	—	.001	31.00	"
Cup Gear	G	C.I.	1/2	.02	.0015	—	.005	.001	27.50	"
Spur Gear	H	C.I.	1/16	.0025	—	.0005	—	.001	4.00	"
Cyl. disc	C	C.I.	1/16	.0025	.01	.001	—	.004	17.50	"
Plug	Y	C.I.	1/8	.005	.002	.0001	—	—	7.10	"
Pipe Plugs	—	C.I.	—	—	—	—	—	—	12.00	"
Washers	U	Steel	40	—	—	—	—	—	1.92	Strelinger
Cotter Pins	T	Steel	—	—	—	—	—	—	1.12	"
Plunger Spg.	F	Steel	—	—	—	—	—	—	3.60	"
Dog spg.	Q	Steel	—	—	—	—	—	—	3.00	Estimate
Taper Pins	—	Steel	—	—	—	—	—	—	.45	"
Flat Spg.	R	Steel	—	—	—	—	—	.0005	5.00	"
Cam	E	Steel	1/8	.0125	—	.0015	—	—	14.50	"
Pins	—	Steel	—	—	—	—		—	.32	Strelinger

Piece	Symbol	Material	Weight	Cost Raw	Cost Lathe	Cost Drill Pr	Cost Aut Mch.	Cost Misc	Cost 1000	Basis of Est
Screws 6-32	X	Steel	—	—	—	—	—	—	4.80	
Set Screws	—	Steel	—	—	—	—	—	—	10.72	
Brass	JKV	Brass	1½	.25	—	—	.03875	—	288.75	
Plunger	D	Brass	—	—	.02	—	.01	—	30.00	
Arm Dog	P	Steel	—	—	—	—	—	—	2.00	
Lost Motion D	W	Steel	150	9.00	—	—	.0005	—	9.50	
Thumb scw	—	M.I.	—	—	—	—	—	—	48.00	
Painting	—	—	—	—	—	—	—	—	10.00	
Assembling	—	—	—	—	—	—	—	—	30.00	
Packing	—	—	—	—	—	—	—	—	60.00	

Estimated Cost	1845.43
Contingent Factor 5%	74.2715
Total Estimated cost per 1000	1559.7015
Cost per single Oiler	\$1.559

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Approved H. J. Thorkelson

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